NASA Procedural Requirements

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Request Notification of Change (NASA Only)

Subject: Facilities Maintenance and Operations Management

Responsible Office: Facilities Engineering and Real Property Division

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Appendix H. Annual and Five-Year Maintenance Work Plan Template

H.1 Introduction

NASA has adopted a maintenance philosophy that emphasizes using the optimal mix of strategies to provide required facility availability and reliability at minimum cost in order to support current and planned NASA programs.

One of the recognized deficiencies in complying with this philosophy is the lack of an effective long- and short-range planning process at most of the Centers and their Component Facilities across NASA. Since all the Centers are moving toward a fully implemented Reliability Centered Maintenance (RCM) program, the next step is to provide them with a vehicle to display long- and short-range facility requirements in a manner that can be used to articulate needs based on mission impact and most probable facility availability outcomes under varying budget scenarios.

This document provides an Annual and Five-Year Maintenance Work Plan template. A business plan approach has been used to integrate smoothly into NASA's strategic management process, afford Center Facility Management (FM) and senior managers the ability to make risk-based decisions regardless of the budget environment, and allow Center FM organizations to pursue and measure their continuous improvement efforts.

H.2 Background

Factors considered in developing the template include NASA's Integrated Enterprise Management Program (IEMP) and full-cost accounting, the asset management initiative, PBC conversion initiative, implementation of ISO 9000-quality process requirements into the NASA business process, and Agency-wide metrics requirements recently incorporated in the facilities maintenance self-assessment policy.

This is a template, a suggested approach to structuring (format and content) an Annual and Five-Year Maintenance Work Plan. It has been designed to assist Center FM managers in preparing sound strategies, performing risk-based management, and identifying the required resources to help enable Center and Agency goals. Center FM managers have maximum flexibility in tailoring the plan to meet individual Center needs.

Funding throughout the plan is based on current year dollars. All funding amounts within any category should reflect fully loaded (that is, all support costs) funds. For example, if a NASA contractor is developing a plan, which may become part of a larger plan, then all funding should reflect the fully loaded price to NASA. The fully loaded price would include all costs and fees (profit). In some cases, the plan will reflect contract fixed prices.

Funding needs are developed within the requirements analysis in section 3. When coupled with criticality issues, such as affect on mission or safety, it becomes an effective tool for identifying work that cannot be accomplished if the budget is reduced, as well as the highest priority backlogged work that could be accomplished if additional resources were made available.

The Annual Work Plan (AWP) is the first year, or base year, of this plan. The base year information shall be as

complete and accurate as possible. In addition, the base year shall identify work that will be deferred if the proposed budget is not completely funded and the effect on the Center/Facility if that work is not performed. The outyears, beyond the base year, are estimates that will form the basis of future AWPs.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Annual and Five-Year (Facilities or Area) Maintenance Work Plan

Center Name
Starting Fiscal Year <INSERT YEAR>
(October 1, <INSERT YEAR> through September 30, <INSERT YEAR>)

Prepared By: xxxx
POC: Name
Telephone: (xxx) xxx–xxxx
e-mail: abc@nasa.gov

Executive Summary

NOTE TO AUTHOR: The Executive Summary will summarize the long- and short-term goals and funding requirements for the facilities maintenance organization. The objective is to present the "big picture" including any requirements that cannot be accomplished within the established budget guidelines. Any adverse trends that could affect facility availability need to be described along with their probability of occurrence and their effects on safety, mission, or other costs. This is the opportunity to clearly articulate potential problems from reduced funding and the adverse impact they could have on mission support. If space allows, describe new initiatives and objectives, successes achieved to date, other initiatives outside of facilities maintenance, and funding requirements to continue them.

An effective Executive Summary should be short and concise. A good length is two to five pages. The goal is to have no surprises. If it is important, it should be mentioned here. Details must be provided somewhere within the plan for every item mentioned in this summary. The details are backup information such as a table, an appendix, or a reference to other Center data.

Funding History

All funds are in actual/current year dollars (identify if K$ or M$).

Funding	Actual		Projected				
Source	FY(X–2)	FY(X–1)	FY(X)	FY(X+1)	FY(X+2)	FY(X+3)	FY(X+4)
R&D							
Other							
Other							
Total							

NOTE TO AUTHOR: The funding chart above will show "big picture" funding for all fund sources (FS) received in current and previous fiscal years as well as proposed for the five-year period. Adverse trends depicted in the chart should be identified and their impact on mission support described. The text that follows provides an example of what could be included in this section.

The term "Center" is inclusive of its Component Facilities, as applicable.

The funding history and projected requirements to support facility maintenance for <INSERT CENTER NAME> are shown above. The funding for <INSERT CATEGORY> has been < INSERT "INADEQUATE," "FALLS SHORT" ETC.> and has resulted in <INSERT ADVERSE EFFECTS>. If additional funding is not made available, < INSERT POTENTIAL FUTURE PROBLEMS>.

The following chart, together with backup details, is the proposed < INSERT CENTER NAME> Annual Work Plan for the upcoming fiscal year.

Spending by NASA Category - (Current Year <X> and Budget Year <X+1>)
All funds are in current year dollars (identify if K$ or M$).

Work Element	FY <X>	% Effort	FY <X+1>	% Effort
PM/PT&I				
Grounds Care				
PGM				
Repair				
Trouble Calls				
ROI				
Plant O&M				
Subtotal				
DM				
Special Programs				
Service Requests				
Subtotal				
CoF - Discrete				
CoF - Minor				
Total		100		100

NOTE TO AUTHOR: The chart above should show all NASA categories of work and all other categories of work to be managed by the facilities maintenance group. The Work Element column in the chart can include any number of items. Keep in mind, to be effective, the chart should limit the items by rolling up funds from the details contained within this plan. Backup details of specific requirements within each Work Element item should be available in an appendix, within the plan, or in a specifically referenced document or source. The percentage effort refers to the percentage of overall effort that the particular category represents. Include other charts and graphs to highlight performance and new initiatives. Include pictures here and in the body of the Plan if they add value.

Facilities Assessment Summary

NOTE TO AUTHOR: The following section is an overall assessment of past, present, and future funding trends, anticipated needs, and the ability of current budget estimates to meet needs required to successfully support the Center mission. This section is a summary of Section 4.3 and Appendix F. An example of information that can be portrayed is shown below.

State of <INSERT CENTER NAME> Facilities in Supporting the Center's Mission and Center of Excellence Responsibilities

<INSERT CENTER NAME> mission is to <INSERT MISSION> and is NASA's Center of Excellence for <INSERT COE RESPONSIBILITY>. Facilities maintenance organization's vision and mission are <INSERT VISION AND MISSION>. Major active facilities maintenance programs include <INSERT MAJOR PROGRAMS TO SUPPORT MISSION>. Future Center programs planned include <INSERT FUTURE PROGRAMS PLANNED>. The current state of <INSERT CENTER NAME> facilities for providing the required reliability and availability to support these programs is <INSERT "GOOD," "FAIR," "MARGINAL," OR "POOR">.

The current budget <INSERT EITHER "MEETS" OR "FALLS SHORT OF"> anticipated needs to ensure facilities maintain a reasonably high probability of supporting current mission needs. <INSERT THE FOLLOWING APPROPRIATE ITEMS WHEN REQUIREMENTS ARE GREATER THAN RESOURCES AVAILABLE – "THE FOLLOWING IDENTIFIES ACTUAL RESOURCE REQUIREMENTS, RESOURCE SHORTFALLS, REQUIRED WORK THAT CANNOT BE ACCOMPLISHED WITHIN THE AVAILABLE BUDGET, AND POTENTIAL MISSION IMPACT OF NOT ACCOMPLISHING THE REQUIRED WORK:" >

Preventive/Predictive Maintenance - <IDENTIFY RESOURCE REQUIREMENTS, RESOURCES BUDGETED, REQUIREMENTS THAT CANNOT BE ACCOMPLISHED, AND SHORT- AND LONG-TERM PROJECTED MISSION IMPACTS>

Programmed Maintenance - <SAME AS PM/PT&I >.

Repairs - < SAME AS PM/PT&I >.

Replacement of Obsolete Items - < SAME AS PM/PT&I >.

Utility Plant Operations - < SAME AS PM/PT&I >.

Grounds Care - < SAME AS PM/PT&I >.

Proactive Maintenance - < IDENTIFY COST EFFECTIVE METHODS REQUIRED TO MINIMIZE FAILURES NOT ABLE TO BE ACCOMPLISHED DUE TO BUDGET SHORTFALLS AND THE POTENTIAL SHORT- AND LONG-TERM IMPACTS >.

Special Programs – <INSERT SPECIAL PROGRAMS NOT ABLE TO BE ACCOMPLISHED DUE TO BUDGET SHORTFALLS AND INSERT THEIR BENEFITS AND POTENTIAL IMPACTS ON THE CAPABILITY TO SUPPORT MISSION >.

CoF Repairs/Revitalization - < IDENTIFY CURRENT YEAR NEEDS, FUNDED PROJECTS, AND POTENTIAL IMPACT OF UNFUNDED PROJECTS >.

Deferred Maintenance (DM), formerly known as Backlog Maintenance and Repair, is currently at <INSERT $$ VALUE> or <INSERT %> of Current Replacement Value (CRV), and is expected to increase/decrease by <INSERT VALUE> in the coming year due to < INSERT PRIMARY CAUSE>. Primary mission impacts of existing DM are as follows:

1. <INSERT MOST SIGNIFICANT IMPACTS>.

2. ETC.

Facilities systems having a **high probability of incurring unplanned downtime** due to system condition and the most probable mission impact are as follows:

1. <INSERT SYSTEM #1 AND PROBABLE IMPACT>.

2. ETC.

Facilities systems having a **medium probability of incurring unplanned downtime** due to system condition and the most probable mission impact are as follows:

1. <INSERT SYSTEM #1 AND PROBABLE IMPACT>.

2. ETC.

Table of Contents

1.0 Introduction

NOTE TO AUTHOR: This section of the Annual and Five-Year Maintenance Work Plan provides the opportunity to explain what the plan is, why it was prepared, and how it can be used. The text that follows provides examples of subjects that may be included in this section.

The term "Center" is inclusive of its Component Facilities, where appropriate.

This document describes the Annual and Five-Year Maintenance Work Plan for < INSERT CENTER NAME> and represents a business plan for the facilities maintenance organization. The Plan identifies long-term and short-term maintenance requirements, describes the resources available and required to manage and accomplish facility maintenance, and outlines the maintenance philosophy and approach for < INSERT CENTER NAME>. Further, it will allow managers to make risk-based decisions on the work to be accomplished regardless of the budget environment, and it identifies specific areas to improve the overall effectiveness of facility maintenance. Overall effectiveness means PROVIDING THE REQUIRED FACILITY AVAILABILITY AT THE LOWEST COST. The plan identifies metrics to be used in tracking progress toward accomplishing these improvements. The AWP is the first year, or base year, of this plan. The outyears, beyond the base year, are estimates that will form the basis of future AWPs.

Throughout this document, the term maintenance is used to represent the compilation of activity undertaken to ensure the required facility availability at the lowest cost. That activity includes traditional maintenance, work done to reduce the probability of failure; repair, the restoration of function following failure; custodial, work done to maintain appearance or sanitation; and some operations. Sometimes it is difficult to place a single activity within one of the above categories. For example, painting provides both a failure prevention and appearance function. In addition, often the most effective maintenance approach is based on monitoring a system or machine condition and performing some activity based on that condition. Is the resultant activity maintenance or repair? This document will provide guidance for working through these issues. The activities include all of the elements identified in *NPR 8831.2, Facilities Maintenance Management.* Abbreviations and acronyms are contained in Appendix A. Other definitions, which are based on the NPR, other NASA documents, and discussions with NASA personnel, are contained in Appendix B.

Facilities maintenance at < INSERT CENTER NAME> is crucial in ensuring facility availability for its critical missions. The effect of reduced maintenance is not always felt immediately. It is, therefore, essential that sufficient management information is available to plan short-term and long-term maintenance requirements properly, recognize adverse funding trends, make the right decisions on what work is not accomplished, and be able to articulate the effect of reduced maintenance on facility availability and the mission.

The plan builds upon < INSERT CENTER NAME> existing mission statements to develop guidance on categorizing facilities and equipment in terms of their criticality and current condition and considers long-range plans that will affect real property assets and future maintenance requirements.

2.0 Center Mission

NOTE TO AUTHOR: This section of the plan builds upon the Center mission, defines the facilities supported and their priority relative to that mission, and looks at long-term facility changes to support the mission. Sample statements are provided below:

The <INSERT CENTER NAME> mission is <INSERT MISSION> and is NASA's Lead Center of Excellence (COE) for <INSERT COE RESPONSIBILITY>. The key mission elements at <INSERT CENTER NAME> that directly and indirectly affect facilities are:

< DEFINE KEY ELEMENTS THAT AFFECT FACILITIES, BASED ON THE CENTER'S STRATEGY TO IMPLEMENT THE MISSION>.

NOTE TO AUTHOR: Categorize facilities (Table 2-1) in terms of mission criticality (determined in partnership with site users and managers), square footage, and CRV for comparison/analysis purposes. One way to do that is to identify the entire Center by core or support function categories. The following terms, currently being considered for use Agency wide, are suggested:

Mission Critical: A building, area, or system that is critical to the Center mission or essential for Center of Excellence performance.

Mission Support: A building, area, or system that provides support to the Center primary mission or Center of Excellence assignment.

Center Support: A building, area, or system that supports the overall operation of the Center but does not meet the Mission Critical or Mission Support criteria.

An example of how to collect and categorize the facilities is provided in Appendix C. An appendix is useful for providing detailed information that is summarized in tables in this section. A map of the Center may also be useful to identify building and area locations.

NOTE TO AUTHOR: Describe any specific requirements that will drive priorities or philosophy of maintenance accomplishment. Describe any known mission changes, funded or unfunded, that will impact existing or future maintenance requirements. Information may be available from the Installation Master Plan, which is prepared and maintained by the Facilities Planning Office. Describe new facilities or facility modifications/repairs that will increase or decrease current maintenance requirements. Sample statements are shown below:

Over the next <INSERT PERIOD> the following known mission changes will have the following impact on maintenance responsibility:

<INSERT KNOWN MISSION CHANGES AND THEIR EXPECTED INCREASE AND/OR DECREASE IN MAINTENANCE RESPONSIBILITY>

Additionally the scope of maintenance coverage will be <INSERT INCREASES AND DECREASES IN TOTAL AREA TO BE MAINTAINED, BUILDINGS, OR AREAS THAT WILL BE BUILT, MODIFIED, BECOME REACTIVATED OR INACTIVE>.

Table 2-1 categorizes facilities in terms of mission criticality, square footage, and CRV for comparison analysis purposes.

Table 2-1: Mission Criticality

NOTE TO AUTHOR: Buildings/areas are based on detailed breakdown (usually in an appendix). Space is gross floor space and does not include grounds (which may be separately identified). CRV is in base year dollars and includes noncollateral equipment (collateral and noncollateral equipment may be separately identified).

Mission	Actual		Projected				
Category	FY(X–2)	FY(X–1)	FY(X)	FY(X+1)	FY(X+2)	FY(X+3)	FY(X+4)
Mission Critical							
Buildings/Areas (No.)							
Space (gross sq. ft.)							
CRV ($)							
Mission Support							
Buildings/Areas (No.)							
Space (gross sq. ft.)							
CRV ($)							
Center Support							
Buildings/Areas (No.)							
Space (gross sq. ft.)							
CRV ($)							
Totals							
Buildings/Areas (No.)							
Space (sq. ft.)							
CRV ($)							

Note: Space is gross floor space and does not include grounds. CRV is in base year dollars and includes noncollateral equipment.

NOTE TO AUTHOR: Identify the staffing of the Center. This may provide an indication of the level of work being performed at the Center. The staff may be NASA civil servants, other Government civil servants, or contract personnel. For fixed-price contracts, personnel figures may not be available or meaningful. A table, similar to the one below, is often effective:

Table 2-2 identifies the actual and projected staffing requirements at <INSERT CENTER NAME>.

Table 2-2: Staffing
Numbers are Full-Time Equivalent Employees.

Staff	Actual		Projected				
Source	FY(X–2)	FY(X–1)	FY(X)	FY(X+1)	FY(X+2)	FY(X+3)	FY(X+4)
NASA							
Other Gov.							
Contractor							
Contractor							
Total							

3.0 Requirements Analysis

NOTE TO AUTHOR: This section is used to develop facility maintenance requirements. Because each Center is unique in its mission, physical plant, and available resources, the method used in determining requirements will vary. In order to accurately identify overall maintenance requirements, key information will need to be available. Some examples of this information include: (1) clear identification of the assets to be maintained (facilities and equipment); (2) their relative importance from a mission/safety/cost standpoint; and (3) indicators of their current material condition from PT&I data and routine or special testing, operational performance data, failure rates, or, in some cases, visual presentation. Comparison to historical funding information will indicate any potential funding shortage and identify backlogs. For all elements defined in this section, an appendix may need to be developed or data outside the plan be referenced that will document a source. Estimates, when used, should be clearly identified.

Tables have been developed for this section to identify maintenance funding requirements and to articulate those needs throughout the organization. It is important that the plan build upon the suggested elements, adding and deleting as needed, and settle on a final array of needed data. When that is completed, the people who have the facility knowledge can be called upon to provide the data. This template builds upon the information and definitions detailed in *NPR 8831.2, Facilities Maintenance Management*. Expansion of definitions or clarification of information is provided when necessary to help in formulating the plan.

This section identifies the facility maintenance requirements at <INSERT CENTER NAME>. The tables that follow identify the assets (facilities and equipment) that must be maintained, their relative importance to the mission of <INSERT CENTER NAME>, and their current condition, operational performance data, and failure rates. Historical funding data, including funding shortfalls and consequent maintenance backlogs, are also presented.

3.1 Requirements by Building or Area

NOTE TO AUTHOR: This section is used to develop facility maintenance requirements for each building or area identified in section 2. This section provides suggested elements to consider. The building/area approach is suggested in order to ensure a systematic development and prioritization of needs for varying budget scenarios, and to enable gathering information from knowledgeable people, such as systems engineers and building or area managers. Those systems that provide broad Center support, such as utilities, are documented in section 3.2.

This section identifies the facility maintenance requirements for each building or area identified in section 2. Those systems that provide broad Center support, such as utilities, are discussed in section 3.2.

3.1.1 Criticality and Condition

NOTE TO AUTHOR: Even if a building or area is Mission Critical, not all systems within that area are necessarily critical. It is expected that some systems that provide Center support will be important from a maintenance perspective. It is, therefore, necessary to identify systems within the building or area (or, if needed, subsystems) by a criticality code.

Several methods for assigning criticality have been developed to support the RCM evaluation process and other reliability efforts. The methods are discussed in Appendix D, Developing System Criticality.

In addition to criticality, the condition of a facility component or item of equipment is also an important factor in identifying long-term requirements and their relative priorities. Condition codes, based on *NPR 8831.2, Facilities Maintenance Management*, have been expanded and are listed in Table 3-1

below. As written in the NPR, the codes focus on age and appearance. The expanded definitions, while still subjective in nature, build upon NASA's PT&I and other monitoring capabilities.

Centers may want to use Table 3-1 in their plan. When Table 3-1's listing of systems and their Criticality and Condition Codes is prepared using a spreadsheet or database program, it can be sorted easily on any one of the columns. The table is useful in that it establishes a relationship between criticality and condition for all systems within the building or area. If the table is included in the plan, it should be in an appendix.

Table 3-1 is a listing of systems and their Criticality and Condition Codes based on an expanded version of the definitions in *NPR 8831.2, Facilities Maintenance Management*, as follows:

Condition Code 5 - Excellent – No work required - Good for at least five years.

Condition Code 4 - Good – Only scheduled maintenance and/or condition monitoring required – Good for at least five years.

Condition Code 3 - Fair – Minor repairs required – Repair/replace within three to five years.

Condition Code 2 - Poor – Significant repairs required within one to two years.

Condition Code 1 - Bad – Replacement required now.

The expanded definitions, while still subjective in nature, build upon NASA's PT&I and other monitoring capabilities.

The table correlates criticality and condition for all systems within their respective buildings or areas.

Table 3-1: System List with Criticality and Condition Codes
Criticality Codes are based on the Dual-Code Method (see Appendix D).

System	Criticality Code		Condition Code
	Function	Cost	
Chiller 5	3	1	4
Air Handler 20	4	4	3
Air Handler 9	3	1	4
Lift Pump 1	2	1	2
Lighting System A	4	2	5
Motor Control Center 4A	1	1	5

NOTE TO AUTHOR: Keep in mind that the material condition (as reflected in the Condition Code) is a snapshot in time. Plan on updating the condition, at a minimum, every five years. Most organizations try to update the condition of at least 20 percent of all systems each year, as part of their Facilities Condition Assessment (FCA) programs. Condition monitoring (PT&I) will provide a much more accurate indication of condition because the data is collected and analyzed on a more frequent basis.

Table 3-2 provides a summary of the number of systems within each condition code category. For example, in Table 3-1, two systems have Function Code 3 and Cost Code 1 (Chiller 5 and Air Handler 9). Also from Table 3-1, those two systems are Condition Code 4. So, in the following summary table below, there would be the number 2 in row 3,1.

Table 3-2: Systems by Condition and Critical Code
Table contains the number of systems that meet the criticality and condition criteria.

Criticality		Condition Code				
Codes		(1-Bad, 2-Poor, 3-Fair, 4-Good, 5-Excellent)				
Function	Cost	1	2	3	4	5
1	1					1
1	2					
1	3					
1	4					
2	1		1			
2	2					
2	3					
2	4					
3	1				2	
3	2					
3	3					
3	4					
4	1					
4	2					1
4	3					
4	4			1		
Total		0	1	1	2	2

3.1.2 PM and PT&I

NOTE TO AUTHOR: Use this section to develop PM and PT&I funding for the next five years. Funding requirements are the funds needed to perform the scheduled PM and PT&I on all equipment covered by this plan and include all labor, parts, materials, and special tools. A listing of the equipment covered is normally available from the Computerized Maintenance Management System (CMMS) and/or the PT&I database. This could also be specified in a fixed-price contract, if one is in place. The RCM process enables clear identification of what is the most effective maintenance, i.e., what activity provides the highest reliability (reduced probability of failure) at the lowest cost. When systems are analyzed using the RCM process, it is often the case that the existing PM is identified as ineffective and can be replaced with PT&I or a run-to-fail approach. PT&I is used to monitor the system condition and take action (which can be a maintenance or repair activity) when conditions change. Therefore, this section should identify changes expected as the RCM process is used. For fixed-price contracts, this may be a step change when the contract ends (due to changes in the maintenance approach over the life of the contract). Note that PM and PT&I are scheduled activities. Work resulting from changing material conditions, as monitored by PT&I, is not part of this category. System and equipment changes (additions or deletions) may also result in changes in this section. Only major changes (for example, deactivation of a building wing or removal of a test area) need to be discussed.

Table 3-3 identifies required PM and PT&I funding for the next five years. Funding requirements are the funds needed to perform the scheduled PM and PT&I on all equipment covered by this plan and include all labor, parts, materials, and special tools.

Table 3-3: PM and PT&I Funding
All funds are in current year dollars (identify if K$ or M$).

Activity	Fiscal Year				
	FY(X)	FY(X+1)	FY(X+2)	FY(X+3)	FY(X+4)
PM					
PT&I					
Total					

3.1.3 Grounds Care

NOTE TO AUTHOR: Usually grounds care funding requirements are for broad Center areas and should be identified in section 3.2. Include the funding in this section only if it is clearly associated with this building or area. As was the case for PM and PT&I, funding requirements are the funds needed to perform the scheduled work (grass cutting, plant trimming, etc.) for the building or area covered by this section of the plan and includes all labor, parts, materials, and special tools. A listing of the grounds care may be available from the CMMS or in a fixed-price contract. In order to improve planning and management, the work to be performed may be identified by area, zone, or season.

Table 3-4 identifies grounds care for a specific area or zone.

Table 3-4: Grounds Care Funding
All funds are in current year dollars (identify if K$ or M$).

Grounds	Fiscal Year				
Care	FY(X)	FY(X+1)	FY(X+2)	FY(X+3)	FY(X+4)
Area/Zone 1					
Area/Zone 2					
Area/Zone 3					
Total					

3.1.4 Programmed Maintenance (PGM)

NOTE TO AUTHOR: PGM is similar to PM and PT&I in that it is a scheduled activity intended to prevent failure. However, as identified in *NPR 8831.2, Facilities Maintenance Management*, the activity occurs on a greater than one-year cycle. Use this section to identify funding requirements which, by the nature of the work, are not expected to be a "level" amount. In addition, this section needs to be adjusted based on emerging conditions as discussed in the NPR. Ensure that these requirements are not duplicated in any other category of work.

Table 3-5 identifies PGM requirements for a specific area or zone.

Table 3-5: Programmed Maintenance Funding
All funds are in current year dollars (identify if K$ or M$).

	Fiscal Year				
	FY(X)	FY(X+1)	FY(X+2)	FY(X+3)	FY(X+4)
PGM Area/Zone 1					
PGM Area/Zone 2					
PGM Area/Zone 3					
Total					

3.1.5 Repair and Trouble Calls

NOTE TO AUTHOR: From *NPR 8831.2, Facilities Maintenance Management*, repair is "...fixing something broken or failing." This means to restore the function within the funding guidelines identified in the NPR. Trouble calls are a subset of repair in that they are low-cost repairs. The funding limit guidelines for repairs and trouble calls (currently $500,000 and $2,000, respectively) are identified in the NPR and may change from time to time.

Individual failures are usually unplanned events. However, they are not unexpected. In fact, one outcome of the RCM analysis process could be that RTF may be the most cost-effective maintenance approach for some equipment. When this is the case, the equipment or system is usually a low-cost, noncritical, easily repaired item. This section is used to budget funds to provide for repairs and trouble calls. Funding requirements are the funds needed to perform repairs and trouble calls on all equipment covered by this plan and include all labor, parts, materials, and special tools. The systems to be repaired may have items not included in the CMMS and/or the PT&I database.

The repair and trouble call budget is built upon history. First, determine how much repair work this building or area has required in the past, then factor in the material condition and the maintenance approach established by the RCM process. For example, suppose a large amount of scheduled maintenance is reduced and replaced with monitoring through a PT&I program. Initially, repair cost would be expected to increase because the PT&I program is uncovering degraded conditions that must be repaired. They are repaired to reduce the effects of catastrophic failure and to improve the availability to perform operations, testing, research, or whatever the building or area is designed to produce. Then, over time, the repair cost should decrease as the systems perform at a higher level of reliability.

This work may be specified in a fixed-price contract, if one is in place, and will have an upper-level limit on the amount of money the contractor must commit to repair an item (sometimes called the limit of liability). There may be a need to budget for repair beyond the upper limit or to budget for trouble calls above a level specified in the contract.

Carefully consider other funding categories that may influence the outyear projections. For example, a Replacement of Obsolete Items project (discussed in the next section) would be expected to reduce the projected repair costs.

Table 3-6 identifies funding requirements needed to perform repairs and trouble calls on all equipment covered by this plan and includes all labor, parts, materials, and special tools.

Table: 3-6 Repair and Trouble Calls Funding
All funds are in current year dollars (identify if K$ or M$).

Activity	Fiscal Year				
	FY(X)	FY(X+1)	FY(X+2)	FY(X+3)	FY(X+4)
Repair					
Trouble Calls					
Total					

3.1.6 Replacement of Obsolete Items (ROI)

NOTE TO AUTHOR: ROI is a category of systems that are cheaper to replace than to continue to operate or repair. Candidates for ROI are identified through RCM analysis, periodic review of repair costs, and the PT&I program. This section provides the opportunity to present ROI items and to discuss the cost and availability implications of not completing them. One result may be increased repair costs or reduced safety margins. Another result could be extended loss of availability of the building or area if a failure were to occur.

Table 3-7 identifies total planned ROI for a specific building or area. The table also shows any projected increase in other categories (such as repair and TCs) if the ROI is not funded.

Table 3-7: ROI Funding
All funds are in current year dollars (identify if K$ or M$).

	Fiscal Year				
	FY(X)	FY(X+1)	FY(X+2)	FY(X+3)	FY(X+4)
ROI Project 1					
ROI Project 2					
Total ROI					
Increase Due to Unfunded ROI					
Repair					
Trouble Calls					
Total Other					

3.1.7 Service Requests (SR)

NOTE TO AUTHOR: SR requirements can be stated as a lump-sum item or by area/zone. Funding for SRs is provided by the requester. Budget estimates are developed from historical levels of work and are useful for estimating staffing or subcontracting levels.

Table 3-8 identifies SR requirements, where they are shown as lump-sum items or by area/zone.

Table 3-8: Service Request Funding
All funds are in current year dollars (identify if K$ or M$).

Service	Fiscal Year				
Requests	FY(X)	FY(X+1)	FY(X+2)	FY(X+3)	FY(X+4)
Area/Zone 1					
Area/Zone 2					
Area/Zone 3					
Total					

3.1.8 Central Utility Plant Operations and Maintenance (O&M)

NOTE TO AUTHOR: As discussed in *NPR 8831.2, Facilities Maintenance and Operations Management*, the central utility plant O&M funds account for operators and operator-performed maintenance. (Other facilities work may also fit this category. For example, research facilities may utilize the same personnel to perform operations and maintenance.) Do not include funding for other work performed in the building or area, such as PT&I or repair. There is also a need to account for automation improvements, including online condition monitoring systems that could reduce the funding requirements.

Table 3-9 identifies central utility plant funding requirements.

Table 3-9: Central Utility Plant O&M Funding
All funds are in current year dollars (identify if K$ or M$).

Central Utility	Fiscal Year				
Plant O&M	FY(X)	FY(X+1)	FY(X+2)	FY(X+3)	FY(X+4)
Total					

3.1.9 Construction of Facilities (CoF)

NOTE TO AUTHOR: In this section, identify funding to perform or support projects, including all CoF and environmental projects. Do not include funding controlled or used by other organizations to perform or support the CoF work. Only facilities maintenance funds are included here. For example, funding to support the construction, acceptance, and baseline condition monitoring/testing of a new building (or portion of this building or area), if performed or managed by the facilities maintenance organization, should be included in this section.

If available, evaluate the Five-Year CoF plan. Requirements for both construction and repair categories should be detailed in the CoF plan and include restoration, modernization, rehabilitation, and repair projects. Projects less than $500,000 are normally funded by the Center. Minor program CoF projects are those between $500,000 and $5.0 million. Major program or discrete CoF projects are greater than $5.0 million. Environmental projects are normally funded from a special-fund source.

The information in this section should also relate to other sections. For example, a CoF project scheduled for completion in FY 2002 could result in increased PM and PT&I in FY 2003 as new systems are maintained or monitored. This section of the plan should fully develop the life-cycle maintenance implications of CoF and other projects that will eventually be maintained by the organization. This includes projected funding needs for the completed project. Once the project is completed, the outyear

funding would be integrated with the other sections of the plan (for example, any PM/PT&I that is accounted for here will become part of the PM/PT&I section once the project is completed).

Table 3-10 identifies funding to perform or support projects, including all CoF and environmental projects.

Table 3-10: CoF Funding
All funds are in current year dollars (identify if K$ or M$).

Project	Fiscal Year				
Type	FY(X)	FY(X+1)	FY(X+2)	FY(X+3)	FY(X+4)
CoF - Major					
CoF - Minor					
Other					
Total					

3.1.10 Deferred Maintenance (DM)

NOTE TO AUTHOR: NPR 8831.2, Facilities Maintenance and Operations Management, provides a detailed discussion regarding DM. From the NPR, DM is unfunded facilities maintenance work. Only those items that support the Center's mission goals are to be included in the DM calculation. In this section, two tables are needed to present DM history and plans to reduce DM. The first table, the history, documents the DM for the previous five years in order to identify the DM trend. The second table identifies needed DM reduction funds. This section should discuss the DM priorities and the effect of not completing the DM . Ensure that DM requirements are not duplicated in any other category of work. The tables can be prepared for each of the facility types (mission critical, mission support, and center support) if desired.

Table 3-11 documents the DM for the previous five years in order to identify the DM trend.

Table 3-11: DM History
All funds are in actual dollars (identify if K$ or M$). Start is DM at start of the fiscal year. Reduction is reduction of DM during the year. End is the remaining DM at year's end (and becomes the next year start).

DM	Fiscal Year				
	FY(X–5)	FY(X–4)	FY(X–3)	FY(X–2)	FY(X–1)
Start					
Reduction					
End					

Table 3-12 identifies needed DM reduction funds.

Table 3-12: DM Reduction Plan

All funds are in current year dollars (identify if K$ or M$). Start is DM at start of the fiscal year. Reduction is planned reduction of DM during the year. End is the remaining DM at year's end (and becomes the next year Start).

DM	Fiscal Year				
	FY(X)	FY(X+1)	FY(X+2)	FY(X+3)	FY(X+4)
Start					
Needed Reduction					
End					

3.1.11 Special Programs

NOTE TO AUTHOR: This section of the plan identifies funding requirements for special programs not identified elsewhere in the Plan. Special programs could include completing an RCM analysis and implementing changes, initiating or expanding the PT&I program, planning and performing CMMS upgrades, refrigerant conversion, building closures, or special training not accounted for elsewhere. This section should discuss the program, the source of funding, the expected benefits or reason for the program, and the implication or effect of not completing the program. Other work may also be included in this section. For example, custodial work is not a work area separately identified elsewhere in the plan. If custodial work is part of the organization's responsibility, the decision may be to include it here. This may also be a good place to budget for special events and weather-related contingencies, such as snow removal or wind damage. Funds not used for the contingency can be applied to DM.

Table 3-13 provides funding requirements for special programs not identified elsewhere in the plan.

Table 3-13: Special Program Funding

All funds are in current year dollars (identify if K$ or M$).

Special Programs	Fiscal Year				
	FY(X)	FY(X+1)	FY(X+2)	FY(X+3)	FY(X+4)
Implement RCM					
PT&I Program					
CMMS Upgrade					
Special Program A					
Special Program B					
Special Program C					
Custodial Work					
Total					

3.2 Requirements for Broad Center Support

NOTE TO AUTHOR: This section is optional. If used, the section develops the facility maintenance requirements for broad Center support items, such as utilities. The list of broad support items is identified in section 2. This section should be developed for all detailed topics used in section 3.1.

This section identifies the facility maintenance requirements for the broad Center support items identified in section 2.

<INSERT THE REQUIRED DATA FOLLOWING THE SAME FORMAT PRESENTED IN SECTION 3.1 FOR SPECIFIC FACILITIES AND AREAS>.

3.3 Five-Year Funding Plan

NOTE TO AUTHOR: Table 3-14 consolidates the funding requirements identified in section 3.1 and section 3.2. and provides the projected facilities maintenance funding requirement for the Center. The table in this section may be all that is required.

Table 3-14 consolidates the funding requirements identified in section 3.1 and in section 3.2. and provides the projected facilities maintenance funding requirement for <INSERT NAME OF CENTER>.

Table 3-14: Five-Year Funding Rollup
All funds are in current year dollars (identify if K$ or M$).

Work Element	FY(X)	FY(X+1)	FY(X+2)	FY(X+3)	FY(X+4)
PM/PT&I					
Grounds Care					
PGM					
Repair					
Trouble Calls					
ROI					
Plant O&M					
Subtotal					
DM					
Special Programs					
Service Requests					
Subtotal					
CoF – Discrete					
CoF – Minor					
Total					

4.0 Facilities Maintenance

NOTE TO AUTHOR: In this section, discuss how Center facilities maintenance will be implemented and monitored. Since each Center is unique in terms of organization, conduct of business, expectations, new initiatives, and planned improvements, the following subsections (4.1 through 4.2.5) describe numerous examples of information that could be included. Each Center should use this section to describe and analyze its own particular situation.

4.1 Maintenance Organization

<IDENTIFY THE MAINTENANCE ORGANIZATION, KEY PEOPLE, AND CONTRACT SUPPORT. DISCUSS THE SUPPORT LEVEL (THAT IS, TO WHAT LEVEL ARE MAINTENANCE AND REPAIR ACTIVITIES PERFORMED ONSITE, LOCAL OUTSIDE SUPPORT, AND OTHER SUPPORT, AS FAR INTO THE FUTURE AS POSSIBLE) AND THE CONTRACT BASIS FOR THAT SUPPORT (LEVEL OF EFFORT, FIXED PRICE, PERFORMANCE-BASED, ETC.). DISCUSS OR PROVIDE THE FACILITIES ORGANIZATION'S MISSION STATEMENT.>

4.2 Maintenance Performance

<DISCUSS HOW BUSINESS IS CURRENTLY BEING CONDUCTED AND IMPROVEMENTS THAT ARE PLANNED>.

4.2.1 Expectations

<PROVIDE THE ORGANIZATION'S EXPECTATIONS AND HOW THEY ARE RELATED TO THE CENTER'S MISSION. CONSOLIDATE EXPECTATIONS BASED ON THE VARIOUS WAYS THE BUILDINGS OR AREAS ARE USED. FOR EXAMPLE, THE EXPECTATION FOR ADMINISTRATIVE BUILDINGS MAY BE TO PROVIDE A SUITABLE WORK ENVIRONMENT, MONDAY THROUGH FRIDAY, FROM 6 A.M. TO 6 P.M. THE EXPECTATION FOR A TEST AREA MAY BE TO ENSURE AVAILABILITY OF TEST SUPPORT FACILITIES AT ANY TIME WITH 48 HOURS ADVANCE NOTICE>.

4.2.2 Initiatives

<IDENTIFY WHAT IS BEING DONE, OR WOULD BE DESIRED, TO IMPROVE PERFORMANCE (FOR EXAMPLE, BAR CODING). HOW WILL THIS SUPPORT THE CENTER'S MISSION? WHAT WILL IT COST, AND WHAT IS THE EXPECTED PAYBACK OR AVOIDED COST? DO NOT DOUBLE COUNT ITEMS DISCUSSED IN SECTION 3 (SUCH AS SPECIAL PROGRAMS), BUT THIS SECTION MAY BE USED TO DEVELOP ITEMS TO BE INCLUDED IN SECTION 3. IDENTIFY WHERE THE FUNDING NEED IS INCLUDED IN SECTION 3. INCLUDE A PLAN OF ACTION AND A MILESTONE CHART (MAY BE IN A SEPARATE DOCUMENT OR AN APPENDIX).>

Table 4-1: Initiative Analysis
All funds are in current year dollars (identify if K$ or M$).

Initiative	Fiscal Year				
	FY(X)	FY(X+1)	FY(X+2)	FY(X+3)	FY(X+4)
Expected Cost					
Avoided Cost					
Total					

4.2.3 Performance Monitoring

NOTE TO AUTHOR: How well are expectations being met and at what cost? In this subsection, develop the indicators to be used to assess performance. Indicators can be event metrics or global metrics.

Event metrics are those items that are useful for measuring progress toward event-type goals, measuring the effect of new initiatives, or winning support for a new approach. While useful, event metrics must be carefully used. For example, when the PT&I program is young, it will often be possible to identify a significant amount of machinery degradation that can be repaired before catastrophic failure occurs (often avoiding a higher cost for the repair and the associated downtime). Measuring "finds" every month, and the avoided costs, are good event metrics because they show how well the new program is working. However, over a long period, as the material condition of machinery systems is raised, the number of monthly finds can be expected to reduce to a fairly stable low level. That could imply (to people unfamiliar with the role of PT&I) that the PT&I program has become ineffective. But why have the PT&I program? The PT&I program's goal to reduce the probability of unexpected failure. So a good global (or strategic) measure would be the number of unexpected failures of monitored equipment or the improved availability (for testing, research, etc.) due to reduced facility equipment failures. Both of these items should improve with time and should be strategically in line with the Center's mission.

Both *NPR 8831.2, Facilities Maintenance and Operations Management*, and the *Reliability Centered Maintenance Guide for Facilities and Collateral Equipment* provide examples of event and global metrics. Existing data collection systems may need to be tailored or a new system added in order to efficiently collect and monitor performance metrics.

An example is breaking down repairs (including trouble calls) into subcategories. Repair means to fix something when it fails; the restoration of function. Sometimes items are repaired before they fail. Is this maintenance or repair? Most people consider any action that improves the material condition or extends the life of the condition to be a repair, not maintenance. The general exception to this is the replacement of low-cost, worn components, such as belts and filters that do not require significant disassembly of the system or machine and are scheduled PM. As the RCM process is implemented, it is expected that ineffective PM will be replaced with more effective PT&I. With increased PT&I, there will be an increase in identification of degraded material conditions that must be repaired in order to avoid catastrophic failure. Some equipment will be allowed to fail; no PM or PT&I will be performed because it is not cost effective. However, it is still a repair when it is fixed. The following table below has been structured to collect repair costs in meaningful subcategories to demonstrate progress toward overall lower repair costs and increased availability.

Table 4-2 illustrates repair costs at <INSERT NAME OF CENTER> by subcategories for the past four years and demonstrates progress toward overall lower repair costs and increased availability as a direct result of performance monitoring.

Table 4-2: Repair Cost Analysis

All funds are in actual year dollars (identify if K$ or M$). Planned repair means that degraded condition has been detected and repair action was scheduled prior to catastrophic failure.

Repair	Fiscal Year			
Subcategory	FY(X–4)	FY(X–3)	FY(X–2)	FY(X–1)
Run-to-Fail Equipment				
Trouble Calls				
All Other Repair				
Subtotal Run-to-Fail				
PT&I Monitored Equipment				
Planned Repair				
Failed Prior to Planned Repair				
Trouble Calls				
Other Unexpected Failure				
Subtotal PT&I Monitored				
All Other Equipment				
Trouble Calls				
Other Unexpected Failure				
Subtotal All Other Equipment				
Total – All Repair				

4.2.4 Staffing and Training Plan

NOTE TO AUTHOR: Based on the information in section 2 and in section 3, what are projected staff and training requirements? Use this section to identify what will be needed such as specialized certifications and licenses, and what will happen if the staffing is not available or if the training is not provided. Carefully factor in new facilities and mission, regulatory requirements, industry standards, and new technologies. If needed, develop a stand-alone needs analysis for staffing and training and display requirements as shown in the following tables:

Tables 4-3 and 4-4 display the projected staff and training requirements at <INSERT NAME OF CENTER> for the next five years. Additionally, the following specialized certifications and licenses are required: <INSERT SPECIALIZED CERTIFICATION/LICENSE REQUIREMENTS>.

If these staffing, training, certification, and licensing requirements are not satisfied, the impact on <INSERT NAME OF CENTER> will be: <INSERT SPECIFIC IMPACTS>.

Table 4-3: Staffing Analysis
Numbers are Full-Time Equivalent Employees.

Staff Function	Fiscal Year				
	FY(X)	FY(X+1)	FY(X+2)	FY(X+3)	FY(X+4)
Management					
Support					
Engineers					
Planners					
Crafts/Trades					
Others					
Total					

Table 4-4: Training Analysis
All funds are in current year dollars (identify if k$ or M$).

Training	Fiscal Year				
Requirement	FY(X)	FY(X+1)	FY(X+2)	FY(X+3)	FY(X+4)
Staff Development					
Regulatory Requirement					
Other Training					
Total					

4.2.5 Special Tools and Test Equipment

NOTE TO AUTHOR: This section is similar to the previous. That section discussed staffing needs. This section concerns tools and test equipment. Identify any expected requirements. Also discuss any major scrap issues related to changing requirements.

Table 4-5 displays the projected special tool or equipment requirements at <INSERT NAME OF CENTER> for the next five years. If these special tool and equipment requirements are not satisfied, the impact on <INSERT NAME OF CENTER> will be: <INSERT SPECIFIC IMPACTS>.

Table 4-5: Tools and Equipment Analysis
All funds are in current year dollars (identify if K$ or M$).

Tools or Test	Fiscal Year				
Equipment	FY(X)	FY(X+1)	FY(X+2)	FY(X+3)	FY(X+4)
Item 1					
Item 2					
Item 3					
Total					

4.3 Budget Shortfall

NOTE TO AUTHOR: Use this section to plan for various budget scenarios. When reductions are proposed, it will be necessary to identify what work will not be performed. And, if not performed, what will be the expected consequence. Should the possibility of a budget "plus-up" occur, it must be possible to identify the highest-priority backlogged items and their positive impact on mission if additional resources are made available. The mission criticality in section 2 identifies building and area importance and the system criticality and condition, identified in section 3, builds upon that to present a total picture of relative importance. Based on their importance and condition, and their projected future use, where would work not be performed if the budget were cut? Several issues must be evaluated. Will the probability of failure increase, and if so, are the consequences of that failure acceptable? If there is an RTF approach for some systems (low-cost, low-risk, easy to fix systems), can repairs be deferred? If the building or area has a limited useful life (perhaps a research or testing effort will be completed relatively soon), can performing maintenance be stopped and a failure risked? In other words, can the resource be consumed? There is a sample Work Priority System in *NPR 8831.2* (See Figure 5-3). This same prioritization process can be used to determine work that would be done if additional resources become available.

The table below can be used to summarize what will be done if the budget is reduced. In developing a reduction plan, keep in mind that some work may be part of fixed price contracts that may not be able to be changed without incurring a penalty. A similar table (Table 4-7) should be developed for a "plus-up" situation.

Table 4-6 summarizes the incremental plan to accommodate budget decreases.

Table 4-6: Budget Shortfall Action Plan
All funds are in current year dollars (identify if K$ or M$).

Budget Shortfall Action Plan - FY <INSERT>		
% Shortfall	$ Amount	Planned Action
1		Defer or eliminate the planned maintenance items identified on Shortfall List 1 (See Appendix F for an example). Change in DM in $.
5		In addition to the above, defer or eliminate the planned maintenance items identified on Shortfall List 2. Change in DM in $.
10		In addition to the above, defer or eliminate the planned maintenance items identified on Shortfall List 2. Change in DM in $.
15		In addition to the above, defer or eliminate the planned maintenance items identified on Shortfall List 2. Change in DM in $.

Table 4-7 summarizes the incremental plan to accommodate budget increases.

Table 4-7: Budget Plus-up Action Plan
All funds are in current year dollars (identify if K$ or M$).

Budget Plus-up Action Plan - FY <INSERT>		
% Plus-up	$ Amount	Planned Action
1		Add work up to this $ amount, as identified in the Priority List of Deferred Work (See appendix F for an example). Change in DM in $.
5		Add work up to this $ amount, as identified in the Priority List of Deferred Work. Change in DM in $.
10		Add work up to this $ amount, as identified in the Priority List of Deferred Work. Change in DM in $.
15		Add work up to this $ amount, as identified in the Priority List of Deferred Work. Change in DM in $.

Appendix A - Abbreviations and Acronyms

(Not Used - See Appendix A of the *NPR 8831.2, Facilities Maintenance and Operations Management*)

Appendix B - Definitions

(Not Used - See Appendix B of the *NPR 8831.2, Facilities Maintenance and Operations Management*)

Appendix C - Center Function Categories (Example)

This appendix provides examples of one Center's facilities using the following criteria:

Mission Critical: A building, area, or system that is critical to the Center's mission or essential for Center of Excellence performance.

Mission Support: A building, area, or system that provides support to the Center's primary mission or Center of Excellence assignment.

Center Support: A building, area, or system that supports the overall operation of the Center but does not meet the mission critical or mission support criteria.

Center Mission –

Assemble, integrate, and check out Space Shuttle elements.

Assemble, integrate, and check out payloads, including the Spacelab, Space Station, and Upper Stages.

Conduct launch, recovery, and landing operations.

Design, develop, build, operate, and maintain launch, recovery, and landing facilities and ground support equipment required to process launch vehicle systems and associated payloads.

Ensure the operation and maintenance of ground support equipment, facilities, and logistics support for all NASA activities at the Center and supported activities.

Manage orbiter flight hardware logistics.

Provide Government oversight of NASA's expendable vehicle launches and NASA-sponsored payloads on both the East and West Coasts.

Table C-1: Listing by Area, Building, or System

If helpful, include a map at end of the appendix.

Area, Building/System Number, Title	Function Category
H2-1198 Jay Jay Railroad Bridge	Mission Support
J6-2262 Orbiter Mate/Demate Device	Mission Critical
J7-0182 Liquid Oxygen(LOX) Facility	Mission Critical
J7-0288 Water Tank	Mission Critical
J7-0337 Launch Pad 39B	Mission Critical
J7-1388 Industrial Water Pump Station	Mission Support
K6-0494 Rotating/Processing Facility	Mission Critical
K6-0696 OPF Hi Bay 3	Mission Critical
K6-0947 Utility Annex	Mission Critical
K6-1091 Emergency Power Station	Mission Support
K6-1096 Operations Support Building	Center Support
K6-1141 Power Substation	Mission Critical
K6-1247 Launch Equipment Shop	Mission Support
K6-1547 Logistics Building	Mission Critical
K7-0853 High-Pressure Gas Storage Building	Mission Critical
K7-1005 Barge Terminal Facility	Mission Support
L6-0146 Engineering and Administration Building	Center Support
L6-0147 Chiller Building	Mission Support
M3-003 Indian River Bridge	Center Support
M6-0399 Center Headquarters	Center Support
M6-0409 Spaceport Central	Center Support
M6-0495 Dispensary	Center Support
M6-0595 Heat Plant	Center Support
M6-0744 Central Supply	Center Support
M7-0505 Payload Support Building	Center Support
M7-0657 Parachute Refurbishment Facility	Mission Support
M7-0777 Canister Rotation Facility	Mission Support
M7-1354 Payload Hazardous Servicing Building	Mission Support
UK-004 Bituminous Roads	Center Support
UK-034 Firex System	Mission Support

Table C-2: Listing by Function Category

Function Category	Area, Building/System Number, Title
Mission Critical	
	J6-2262 Orbiter Mate/Demate Device
	J7-0182 Liquid Oxygen(LOX) Facility
	J7-0288 Water Tank
	J7-0337 Launch Pad 39B
	K6-0494 Rotating/Processing Facility
	K6-0696 OPF Hi Bay 3
	K6-0947 Utility Annex
	K6-1141 Power Substation
	K6-1547 Logistics Building
	K7-0853 High-Pressure Gas Storage Building
Mission Support	
	H2-1198 Jay Jay Railroad Bridge
	J7-1388 Industrial Water Pump Station
	K6-1091 Emergency Power Station
	K6-1247 Launch Equipment Shop
	K7-1005 Barge Terminal Facility
	L6-0147 Chiller Building
	M7-0657 Parachute Refurbishment Facility
	M7-0777 Canister Rotation Facility
	M7-1354 Payload Hazardous Servicing Building
	UK-034 Firex System
Center Support	
	K6-1096 Operations Support Building
	L6-0146 Engineering and Administration Building
	M3-0003 Indian River Bridge
	M6-0399 Center Headquarters
	M6-0409 Spaceport Central
	M6-0495 Dispensary
	M6-0595 Heat Plant
	M6-0744 Central Supply
	M7-0505 Payload Support Building
	UK-004 Bituminous Roads

Appendix D – Developing System Criticality

Several methods for assigning criticality have been developed to support the RCM evaluation process and other reliability efforts. This appendix describes these methods. Regardless of the method used to assign criticality, there is very real benefit to completing the process. That is, once complete, there is a clear understanding of which system failures will have the most significant effect on safety and mission.

Dual-code Method

This method uses two codes, one for function and another for cost. Within the function code, the key elements are safety & environment and mission. Within the cost code, the key elements are operations & maintenance cost and initial (procurement and installation) cost.

Safety & Environment: Does the system perform a safety and environment function? Will a failure of the system hurt people or the environment?

Mission: Does the system support the mission function? Will functional degradation or failure delay or stop the mission? Will functional degradation or failure cause additional significant collateral damage to other systems that will delay or stop the mission? Keep in mind that NASA has a very dynamic environment that results in shifting mission requirements. A system may have a very important function today but have a limited contribution to the Mission a few years from now.

Operations & Maintenance Cost: Does the system have a high operations and maintenance cost (consider all labor and materials including subcontracted work)? High operations and maintenance cost might be defined as $5,000/year or more. This can be any value, as long as it is applied consistently.

High Initial Cost: Did the system have a high initial cost (total installation cost)? Define high initial cost as $50,000 or more. As with high operations and maintenance costs, this can be any value, as long as it is applied consistently.

Answering the above questions resulted in establishing the dual codes as follows:

Function Code 1 - Yes to Safety & Environment and Yes to Mission.
Function Code 2 - Yes to Safety & Environment and No to Mission.
Function Code 3 - No to Safety & Environment and Yes to Mission.
Function Code 4 - No to Safety & Environment and No to Mission.

Cost Code 1 - Yes to Operations & Maintenance and Yes to High Initial.
Cost Code 2 - Yes to Operations & Maintenance and No to High Initial.
Cost Code 3 - No to Operations & Maintenance and Yes to High Initial.
Cost Code 4 - No to Operations & Maintenance and No to High Initial.

Table D-1 lists the codes so that all possible combinations are represented, with the most critical items listed first. The advantage of this method is that it weighs four key elements to define the system criticality.

Table D-1: Dual-Code Criticality

Function Code	Cost Code	Comment
1	1	
1	2	Very Highly Critical: Safety & Environment
1	3	and Mission are both issues.
1	4	
2	1	
2	2	Highly Critical: Safety & Environment
2	3	an issue.
2	4	
3	1	
3	2	Moderately Critical: Mission or
3	3	collateral damage is an issue.
3	4	
4	1	
4	2	Low Critical: No Safety & Environment
4	3	or Mission issues.
4	4	

Streamlined System

This system uses four categories that define criticality of the equipment based on its tie to mission, safety, environmental constraints, and cost. There are variations of this system. For example, the current *Reliability Centered Maintenance Guide* has a similar approach using six categories.

- Critical Code 1 - Mission Critical/High Risk/Catastrophic Impact if Failure Occurs. Equipment must be online for continued mission operation. Loss of any component will result in a system outage and adversely impact mission operations. Also includes all equipment that has extraordinary, high repair costs or excessive spare parts procurement time. Environmental and safety equipment may be included in this classification because failure to conform to law could have grave consequences with regard to mission operations.
- Critical Code 2 - Critical/Process Sensitive/ Major Impact if Failure Occurs. Mission operations would be severely limited if the facility or equipment were disabled. All equipment with chronic maintenance and repair histories or very high repair or replacement costs are in this classification.
- Critical Code 3 - Serious/ Mission Support/ Minor Impact if Failure Occurs. The equipment is costly to maintain but does not directly impact mission. A redundant system would be classified in this category since the online spare could provide the required service. Facilities and equipment seriously impacting other operations, project deadlines, and costs may be within this classification.
- Critical Code 4- Exceptional/ Noncritical/ Discretionary/Deferred/ Negligible Impact if Failure Occurs. All other equipment that does not impact mission is in this category, including equipment that could be maintained but is not essential or equipment that would be maintained if unlimited resources were available.

Process Criticality

Another method for ranking critical systems is adapted from the automotive industry and identifies ten categories.[2] Table D-2 details the system as follows.

Table D-2: Process Criticality

Ranking	Effect	Comment
1	None	No reason to expect failure to have any effect on safety, health, environment, or mission.
2	Very Low	Minor disruption to facility function. Repair to failure can be accomplished during trouble call.
3	Low	Minor disruption to facility function. Repair to failure may be longer than a trouble call but does not delay the mission
4	Low to Moderate	Moderate disruption to facility function. Some portion of mission may need to be reworked or the process delayed.
5	Moderate	Moderate disruption to facility function. 100% of the mission may need to be reworked or process delayed.
6	Moderate to High	Moderate disruption to facility function. Some portion of the mission is lost. Moderate delay in restoring function.
7	High	High disruption to facility function. Some portion of the mission is lost. Significant delay in restoring function.
8	Very High	High disruption to facility function. All of the mission is lost. Significant delay in restoring function.
9	Hazard	Potential Safety, Health, or Environment issue. Failure will occur with warning.
10	Hazard	Potential Safety, Health, or Environment issue. Failure will occur without warning.

[2] *Reliability, Maintainability, and Supportability Guidebook, Third Edition*, Society of Automotive Engineers, Inc., Warrendale, PA, 1995.

Appendix E – Sources of Data (Example)

This appendix describes the sources of data for the work element requirement tables in section 3 that are available to NASA and the Institutional M&O contractor at the Kennedy Space Center. These sources are cited as examples for other Centers/Facilities to use in developing their short- and long-term requirements.

Sources of Data:

Databases/files within the CMMS (MAPCON) – the PM/PT&I Master File, the Work Order History File and the Equipment File are maintained in the Maintenance Management Office of the Institutional M&O contractor.

AMDAHL is a work management system database maintained in the Work Control Office of the Institutional M&O contractor. This system is a unique and separate database to Kennedy Space Center (KSC) and is not tied to the CMMS but tracks service requests (called WAPS at KSC) and facility projects.

The facility projects listing is a locally developed database that is maintained in the Contract Integration Office of the Institutional M&O contractor.

The Facility Project Management System is a NASA-wide database maintained in NASA's Facility Project Management Office.

JAMIS is a financial accounting database maintained in the resources office of the Institutional M&O contractor.

Requirements:

PM/PT&I – Requirements are available from the PM/PT&I Master File and historical information for projections is available from the Work Order History File.

Grounds Care – Historical information for projections is available from the Work Order History File.

Programmed Maintenance – Requirements are available from AMDAHL for in-house work and the facilities projects listing for subcontracted work. Historical information for projections is available from the Work Order History File for in-house work and AMDAHL for subcontracted work.

Repairs – Requirements are available from AMDAHL for in-house work and the facilities projects listing for subcontracted work. Historical information for projections is available from the Work Order History File for in-house work and AMDAHL for subcontracted work.

Trouble Calls - Historical information for projections is available from the Work Order History File.

Replacement of Obsolete Items - Requirements are available from AMDAHL for in-house work and the facilities projects listing for subcontracted work. Historical information for projections is available from the Work Order History File for in-house work and AMDAHL for subcontracted work.

Service Requests - Requirements are available from AMDAHL for in-house work and the facilities projects listing for subcontracted work. Historical information for projections is available from the Work Order History File for in-house work and AMDAHL for subcontracted work.

Utility Plant O&M - Historical information for projections is available from the Work Order History File.

CoF Programs - Requirements are available from the Facility Project Management System.

Table 4.17: DM – Requirements are available from the facility project listing (subcontracts) and the Facility Project Management Database System (CoF projects). Historical information for projections is available from AMDAHL (subcontracts) and the Facility Project Management System (CoF).

Special Programs - Requirements information for these type of programs (including special training requirements) are normally identified, tracked, and maintained in a separate work order or facility project database created to support the specific program.

Appendix F – Budget Shortfall/Plus-up Planning Sheets

Use tables similar to the ones below to detail planned maintenance items to be deferred or eliminated, or added to the budget. Some repair items may also be included.

Column 1 - Item. Ascending numbers/priorities.

Column 2 - Building/area. Identify building or area by name. Include mission criticality code (MC – Mission Critical, MS – Mission Support, CS – Center Support).

Column 3 - Discussion. Identify the system or machine. Identify maintenance to be deferred, eliminated, or added.

Column 4 – Risk/value. Identify what may happen due to not performing work, the consequences of failure, and the probability of the failure or, in the case of a plus-up, the positive effects of accomplishing the work.

Column 5 – DM . Identify DM increase or decrease, if any.

Column 6 - Funds. Identify budget reduction/requirement based on this action.

Budget Shortfall Planning Sheet - FY 1998
List 1 (1% Shortfall)
All funds are in current year dollars (K$)

Page 1 of ___

Item	Building/Area	Discussion	Risk	DM	Funds
1	Test Area 1(MC)	Reduce grass cutting by 50%	None, appearance only.	0	25
2	Building 54 (MC)	Eliminate all PT&I and PM for facilities systems. Selectively perform trouble calls.	Low. All testing in this building is scheduled to be completed this year. Building will be closed at that time. Failures, if they occur, can be repaired with minimal effect on remaining testing. All safety-related maintenance will be performed.	0	80
3	Switchyard (MS)	Defer ROI project to replace aging switchgear	Increased probability of failure. Cannot be quantified. If failure occurs, approx. one-third of the Center will be without power for five days.	250	250
4					
Total				250	355

Budget Plus-up Planning Sheet - FY 1998
List 1 (1%)
All funds are in current year dollars (k$)

Page 1 of ___

Item	Building/Area	Discussion	Value	DM	Funds
1	Building 4240(MC)	Replace electrical distribution system.	Eliminate antiquated system, thereby eliminating high repair costs.	100	100
2					
3					
4					
Total				100	100

Appendix G – Long-Term Budget Planning Sheet

Use a table similar to the one below to detail planned maintenance items beyond the Five-Year window. Some repair items may also be included.

Column 1 - Item. Ascending numbers.

Column 2 - Projected fiscal year and type of work (ROI, CoF, etc.).

Column 3 - Building/area. Identify building or area by name. Include mission criticality code (MC – Mission Critical, MS – Mission Support, CS – Center Support).

Column 4 - Discussion. Identify the system or machine. Identify project/work.

Column 5 - Identify projected funding (if possible).

Long-Term Facilities Budget Items

All funds are in current year dollars (K$)

Page 1 of ___

Item	FY/Type Work	Building/Area	Discussion	Funds
1	2004/CoF	Test Area 4(MC)	Reactivate test area	
2	2005/ROI	Building 32 (MS)	Replace switchgear	
3				
4				
5				
6				
7				
8				

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